Child Growth and Nutritional Status in a High-Poverty Community in Eastern Kentucky

DEBORAH L. CROOKS*
Department of Anthropology, University of Kentucky, Lexington, Kentucky 40506–0024

KEY WORDS socioeconomic status; children; Appalachia; employment; education; gender

ABSTRACT The research reported in this paper examines the relationship between household socioeconomic measures, child growth, and nutritional status in a community in eastern Kentucky with a high rate of poverty. It is based on the premise that child growth and nutritional status reflect the social circumstances in which they occur. 21.6% of the children exhibited low height (<15th percentile of National Center for Health Statistics [NCHS] reference values), with 13% of the girls exhibiting stunting (<5th percentile). Thirty-three percent of the children exhibited overweight, and 13% exhibited obesity (>85th percentile and >95th percentile of National Health and Nutrition Examination Survey [NHANES] reference values, respectively); 21.4% of boys were obese, compared to 8.7% of girls. Analysis of variance indicated that child stature is best explained by the father's education level interacting with employment status, and by the mother's employment status interacting with household poverty level. Weight is best explained by the mother's employment status. However, the relationships among socioeconomic measures and growth outcomes differed by gender of the child. These issues are discussed in light of the anthropology literature and the situation in Bridges County, Kentucky where the research took place. Am J Phys Anthropol 109:129–142, 1999.

There is little disagreement among biological anthropologists that children living in poverty environments face barriers to optimal growth and development. Socioeconomic circumstances that often correlate with poverty place children at risk along a number of pathways (Crooks, 1995). For example, low income may limit access to quality housing, diet, and healthcare, increasing risk of poor health and nutrition, which in turn affect growth and development. Employment status and other socioeconomic measures which are often glossed as socioeconomic status (SES), e.g., educational attainment and occupation, may further impose economic and social hardship and increase risk for children (Duncan et al., 1994). However, the contributions of these individual factors to child growth may be along different paths, or may be of different duration or intensity. In other words, the dynamics of the measures and the relationships among them may differ, as might the outcomes they produce.

Because of anthropology's cross-cultural focus, and the enormity of the malnutrition problem in low-income countries, to date the majority of anthropological research on the relationship between poverty and child growth has taken place outside the U.S. This research indicates a strong relation-

Grant sponsor: National Institute of Child Health and Human Development, National Institutes of Health; Grant number: Fellowship 5 F32 HD07620.

*Correspondence to: Deborah L. Crooks, Department of Anthropology, University of Kentucky, 211 Lafferty Hall, Lexington, KY 40506-0024. E-mail: dlcrooks@pop.uky.edu

Received 6 January 1998; accepted 3 February 1999.

ship between poverty or SES and growth deficits (e.g., Bogin et al., 1989; Cameron, 1992; Crooks, 1994; Islam et al., 1994; Johnston and Low 1995; Singh and Harrison, 1997). Growth deficits are of great concern because of the long-term sequelae associated with them, including reduced immunocompetence, slower cognitive development, and lower work capacity. In addition to growth deficits, growth excesses in the form of overweight and obesity are increasingly reported in low-income countries as they become industrialized and undergo a "nutrition transition" (Popkin, 1994; Popkin et al., 1996). The sequelae associated with overnutrition are also lifelong and include increased risk for cardiovascular disease, diabetes mellitus, hypertension, and some forms of cancer.

In the U.S., there is evidence for an association between poverty, its correlates, and poor growth and nutritional status. Analyses of national data sets show that deficits in height and weight exist for some poor children (Jones et al., 1985; Miller and Korenman, 1994). Recent data from NHANES III indicate that overweight in the general population is increasing at a rapid rate, putting a large portion of the U.S. population at risk for chronic illness (Kuczmarski et al., 1994; MMWR, 1997). And there is evidence that obesity may be more prevalent among the poor (e.g., Okamoto et al., 1993; Sherry et al., 1992; Trowbridge, 1984). However, not all studies report similar outcomes, in that some research indicates that growth deficits, overweight, and obesity may be more prevalent among poor or low SES groups, while other sources do not (reviewed in Crooks, 1995).

Given the variation in research outcomes and the complexities of the relationship between poverty and child growth, additional research is needed in the U.S. But the identification of "poor" children is often difficult. Poverty is most commonly defined relative to income, i.e., enough income to provide "some minimum standard of living to which all society members should have access" (Rural Sociological Society Task Force on Persistent Poverty, 1993). In the U.S., the measure used is the poverty threshold which is calculated as the cost of providing a minimum diet, multiplied by three to account for other household expenditures. This poverty measure is based on annual before-tax income, adjusted for family size (e.g., the 1998 threshold for a family of four was $16,450). However, data on actual income may not be available to researchers, especially those working with children. Children may not be able to report family income, or report it accurately; adults are often reluctant to report income as well. Under these circumstances, poverty status is difficult to determine. Often, qualification for social programs, e.g., Medicaid and the School Lunch Program, is substituted, since qualification is based on a family's economic position relative to the poverty line. However, whether or not these substitutes, or even the poverty line itself, provide a valid measure of poverty is debated, especially since they do not take into account transfer payments or relative differences in cost of living in various parts of the country or between urban and rural places (Focus, 1995, 1998; Ravallion, 1996).

On the other hand, socioeconomic data which tend to correlate with poverty are often readily available to the researcher, e.g., education level, occupation, neighborhood residence, and employment status. These data are used singly, or are aggregated and/or combined with other data in an effort to capture the multidimensional nature of poverty. While these indicators are not without criticism as well, they nevertheless are used when actual measures of income are not available for determining poverty status (Mueller and Parcel, 1981), or when income alone may not adequately reflect the dynamics or effects of poverty (Ravallion, 1996).

The research reported in this paper examines the relationship between available socioeconomic measures, child growth, and nutritional status in a rural community with a high rate of poverty. It is based on the theoretical premise that child growth and development reflect the social circumstances under which they occur (Johnston, 1995). Thus, we can hypothesize that poverty environments will produce poor growth in children. The aims of the paper are twofold: 1) to report the growth and nutritional status of a

sample of schoolchildren from a rural U.S. community with a high rate of poverty, and 2) to analyze the relationship among three socioeconomic measures which tend to correlate with poverty and child growth. The first is a measure of income relative to the poverty line, i.e., eligibility for the School Lunch Program; the second is a measure often used to denote socioeconomic status, i.e., parental education; and the third is a measure of extreme economic hardship, i.e., household employment status.

METHODS

Community and participants

The research took place in a community which lies in the easternmost portion of Bridges County[1] on the edge of the Appalachian Mountains. It is within an area designated by the Appalachian Regional Commission as "distressed," meaning that it has high levels of unemployment and low per capita income. The poverty rate at the time of this research was over 25%, with over 35% of children living in poverty. The area served by Bridges Elementary School (see footnote 1), the location of the research, includes portions of the county that are particularly poor; some families live in substandard housing, lacking electricity, adequate sanitation, and a telephone. Transportation into town for many families is difficult due to distance, poor roads, and lack of vehicles. Not all families, however, experience these circumstances; families in the county represent a range of socioeconomic levels.

The biggest employers in Bridges County are small manufacturing companies, the government, and wholesale/retail trade, in that order (Kentucky Cabinet for Economic Development, Division of Research, 1996). While manufacturing has been a target of Kentucky's economic strategy, the type of manufacturing companies most prevalent in Bridges County are those that provide wages at the low end of the scale. The average weekly wage for residents is around $300 per week. Although agriculture and mining contributed to the economy in the past, they no longer do so (Crooks, 1998); the number of jobs do not meet the needs of the community. The "official" unemployment rate is over 10%; this includes those who are still looking for work. The unofficial rate, which includes those who may have given up the search, is estimated to be over 15% (Crooks, 1998). This research indicates it may be higher, at least among the families of those children in the study.

The participants in the study were 88 children, ages 7–11, drawn from the population of children at Bridges Elementary School. In 1994, with the approval of the University of Kentucky Institutional Review Board, the Director of the Family Resource Center[2] at Bridges Elementary School and I sent letters home to parents of all children in grades 1–5. We did not include kindergarten children because we felt parents might be reluctant to allow their youngest children to be included in the study. We requested permission for the children to participate in the study, and received 102 positive responses out of approximately 230. These children became our preliminary sample. Eleven children moved out of the area during the school year, and were therefore not included in the final sample. In addition, another three children were eliminated from the data analysis because of unreliable data, missing data, or a severe health condition.

The children were European-American, reflecting the ethnic background of the community. We do not know if poor children are overrepresented in this sample. However, 78% of the sample children were eligible for free or reduced-price lunch, which is similar to the 76% reported by the principal for the entire school. Qualification for this program is based on a family's income relative to the U.S. poverty line, as described above. Children qualify for free lunch if their families do not exceed 130% of the poverty line, and reduced-price lunch if they do not exceed 185%.

Data collection methods

All data were collected by the author during the 1994 school year and the begin-

[1]Bridges County and Bridges Elementary School are pseudonyms. The name is taken from my grandfather who was, himself, from the mountains.

[2]Family Resource Centers are funded by the state. Their purpose is to act as liaison between community services and poor families; thus, their mandate goes beyond school issues.

ning of the 1995 school year with the help of the Director of the Family Resource Center. The data reported here are anthropometric data and socioeconomic data. Other data were collected but are not included in this report.

The children's height, weight, right arm circumference, and right triceps skinfold were measured following standard anthropometric techniques. For height, children were asked to stand erect, without shoes, against a stadiometer affixed to a wall; heels, shoulders, and head were touching the vertical surface. The children were instructed to take a deep breath and hold it, their head was adjusted to the Frankfort plane, and a moveable block was brought down to rest on the head. Height was measured twice, and recorded to the nearest 0.1 cm; the average was utilized in analysis. Weight was taken without shoes on a digital Seca scale (Seca Corp., Columbia, MD), calibrated daily. Weight was measured twice in kilograms, clothing was noted, and average weight, adjusted for clothing weight, was used in the analysis. Mid-arm circumference was measured with an insertion tape and recorded to the nearest 0.1 cm. Three triceps skinfold measurements were taken using a Lange skinfold caliper (Cambridge Scientific Instruments, Cambridge, MD); the average in millimeters was used in the analysis. Body-mass index (BMI) was calculated following procedures outlined in Frisancho (1990), as were estimated upper arm fat and arm muscle.

Socioeconomic and household composition data were gathered from children's school files with permission of families. These data are parent-focused and were provided to the school by families at the beginning of the school year. In only one case was the household headed by adults other than parents (in this case, grandparents); they were coded in the data as "parents." In addition, 15 of the 88 children lived in single-parent households; 14 of these were headed by women. The socioeconomic data included: 1) parental education, i.e., did not complete high school, completed high school or general equivalency diploma (GED), or some postsecondary education; 2) father's and/or mother's employment status, i.e., not employed or employed (this is not to be construed as unemployed status; since we have no way to determine whether fathers and/or mothers are actually seeking participation in the labor force, it must be considered a mixed category); and 3) children's eligibility for the School Lunch Program (eligible for free lunch, eligible for reduced-price lunch, or not eligible). Information on parental occupation, other than employment status, was not available from the file. None of the file data were verified with families. However, there is no reason to believe that families would report inaccurate information, since most are well-known to school officials in this small community. Nevertheless, the reliability of the information cannot be assessed.

It is noted that the file data were provided by families at the beginning of the school year (August/September) and that the reported anthropometric measures were collected later, in the spring of the school year (March/May). Therefore, employment status may have changed by the time anthropometric measurements were taken. In addition, eligibility for the School Lunch Program is usually based on income data from the previous year. Therefore, the only socioeconomic measure that likely reflects the family's status when the anthropometric measures were collected is parental education level.

Data analysis

All data were entered into SPSS-PC version 8.0 (SPSS, Inc., Chicago, IL) for analysis. Height and weight were converted to z-scores and percentiles were calculated using the NCHS references for height and weight (Centers for Disease Control, 1990); z-scores and percentiles for BMI, arm circumference, triceps skinfold, upper arm fat, and upper arm muscle were computed using the NHANES data provided in Frisancho (1990). Descriptive statistics for these anthropometric measures are presented in Table 1.

To identify the percentage of children exhibiting stunting and obesity, they were grouped into percentile categories based on height and BMI. The 5th percentile was used as the cutoff for stunting, and the 15th percentile as the cutoff for low height. Cutoffs for overweight and obesity, however, were not as easily determined. Overweight and obesity are assessed in a variety of ways in the literature, utilizing the 85th and 95th

TABLE 1. Mean height, weight, body mass index, upper arm circumference, triceps skinfold, upper arm muscle area, and upper arm fat area for boys and girls separately by age[1]

Boys								
Age (years)	N	Height	Weight	BMI	Arm circumference	Triceps skinfold	Arm muscle	Arm fat
7	5	−0.89 (1.18)	−0.09 (1.38)	0.58 (1.50)	0.58 (1.16)	1.05 (1.24)	−0.07 (0.80)	0.98 (1.29)
8	5	−0.02 (1.19)	0.58** (0.74)	0.72 (0.94)	1.09* (0.83)	0.85 (0.65)	0.84** (0.99)	0.91** (0.70)
9	11	0.17 (0.97)	0.84** (1.49)	0.96 (1.56)	1.20** (1.42)	1.15** (1.30)	0.83 (1.25)	1.27** (1.58)
10	9	0.04** (1.27)	0.66 (1.27)	0.67 (1.27)	0.75 (1.11)	0.65 (1.04)	0.55 (1.28)	0.66 (1.11)
11	11	0.01 (0.88)	0.69 (1.42)	0.64 (1.20)	1.04** (1.39)	0.73 (1.55)	0.89** (1.17)	0.89 (1.68)
12	1	0.08	1.95	2.19	2.31	2.18	1.58	2.44
Girls								
Age	N	Height	Weight	BMI	Arm circumference	Triceps skinfold	Arm muscle	Arm fat
7	3	−0.64 (1.34)	−0.16 (1.00)	0.23 (1.25)	0.26 (0.92)	0.13 (1.12)	0.21 (0.45)	0.16 (1.13)
8	10	−0.88 (1.03)	−0.39** (0.99)	0.07 (0.87)	0.03* (0.88)	0.12 (0.85)	−0.07** (0.78)	0.07** (0.76)
9	12	−0.47 (1.04)	−0.12** (0.98)	0.09 (0.97)	0.26** (0.92)	0.23** (1.17)	0.14 (0.63)	0.23** (1.17)
10	15	0.92** (0.77)	1.10 (1.22)	0.89 (1.29)	1.44 (1.23)	1.26 (0.97)	1.15 (1.35)	1.45 (1.25)
11	6	0.67 (0.73)	0.35 (0.38)	−0.13 (0.43)	−0.53** (0.47)	0.24 (0.38)	−0.06** (0.51)	0.14 (0.38)

[1] All values are z-scores. Standard deviations are in parentheses.
* Boys' and girls' values differ by <.05.
** Boys' and girls' values differ by <.10.

percentiles of weight or BMI, sometimes combined with triceps skinfold measures. Since the majority of research focused on BMI, I chose the convention of using the 85th percentile of BMI as the cutoff for overweight, and the 95th percentile of BMI as the cutoff for obesity.

Table 2 provides descriptive statistics for socioeconomic measures, i.e., fathers' and mothers' education, fathers' and mothers' employment status, household employment status, and qualification for the school breakfast and lunch program. Household employment status is a variable that combines mother's and father's status, i.e., neither parent employed, one parent employed, or two parents employed.

The relationship between the socioeconomic measures, child growth, and nutritional status was explored in two ways. First, one-way ANOVAs and t-tests were used to assess mean differences in anthropometric z-scores by father's education level, mother's education level, household employment status, father's employment status, mother's employment status, qualification for the School Lunch Program, and single-parent household status. Single-parent status was not significant in any of the outcome measures, and therefore was not considered further.

Additional ANOVAs were run (via the general linear model (GLM) factorial procedure) in an attempt to sort out the main and interactive effects of the socioeconomic measures and gender on the two anthropometric variables that exhibited significance, i.e., height-for-age z-scores (HAZ) and weight-for-age z-scores (WAZ). When father's and mother's education and employment status, qualification for the lunch program, and gender were all entered, the resulting model violated assumptions of equality of variances for both HAZ and WAZ (tested via Levene's statistic). Dichotomizing the education vari-

TABLE 2. Descriptive statistics for socioeconomic measures for families participating in the research[1]

Education of father	
Less than high school	40.9
High school/GED	45.5
Some postsecondary	13.6
Education of mother	
Less than high school	29.5
High school/GED	51.1
Some postsecondary	19.3
Father's employment status	
Not employed	35.2
Employed	64.8
Mother's employment status	
Not employed	54.5
Employed	45.5
Household employment status	
Neither parent employed	23.9
One parent employed	42.0
Two parents employed	34.1
Qualification for School Lunch Program	
Free lunch	63.6
Reduced-price lunch	14.8
Paid lunch	21.6

[1] Figures given are percentages of total.

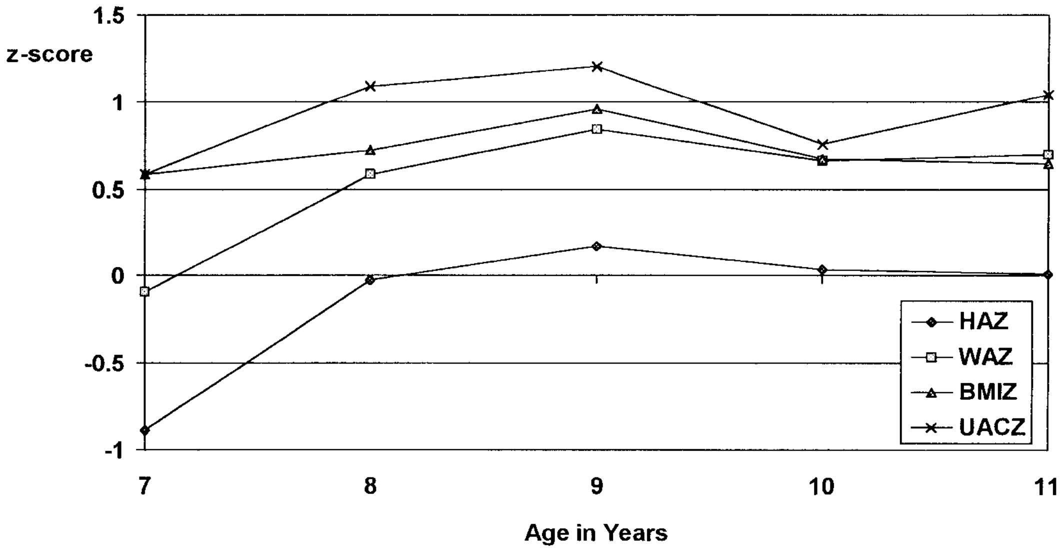

Fig. 1. Boys' z-scores for height (HAZ), weight (WAZ), upper arm circumference (UACZ), and body mass index (BMIZ). HAZ and WAZ were computed using NCHS reference data; UACZ and BMIZ were computed using NHANES reference data.

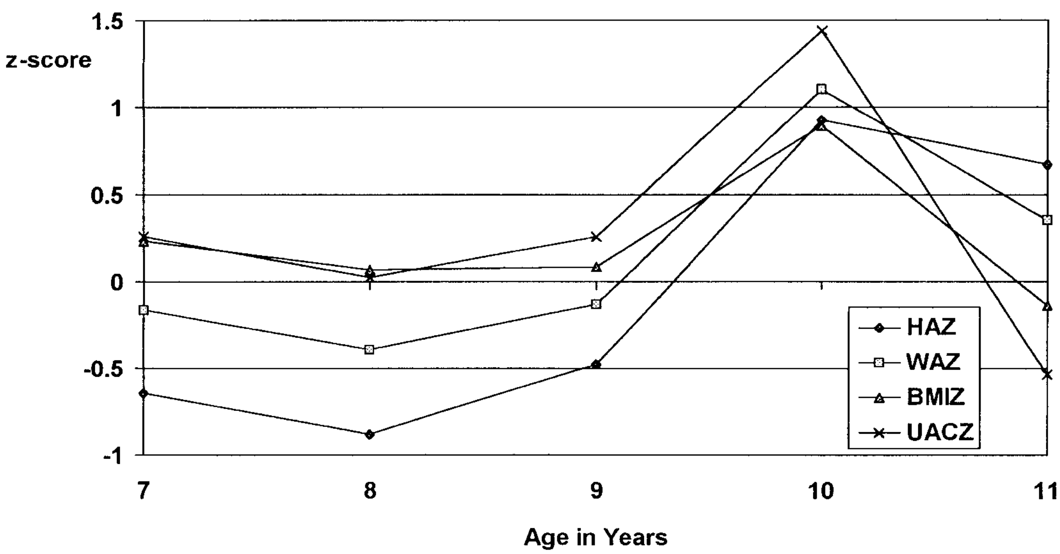

Fig. 2. Girls' z-scores for height (HAZ), weight (WAZ), upper arm circumference (UACZ), and body mass index (BMIZ). HAZ and WAZ were computed using NCHS reference data; UACZ and BMIZ were computed using NHANES reference data.

able (less than high school vs. high school or more) and lunch program variable (qualified for free or reduced-price lunch vs. not qualified) improved the statistic to acceptable levels. Additional tests were then run separately for mothers and fathers.

RESULTS

Growth and nutritional status

Figures 1 and 2 provide an analysis of mean anthropometric measures by age for Bridges Elementary School children com-

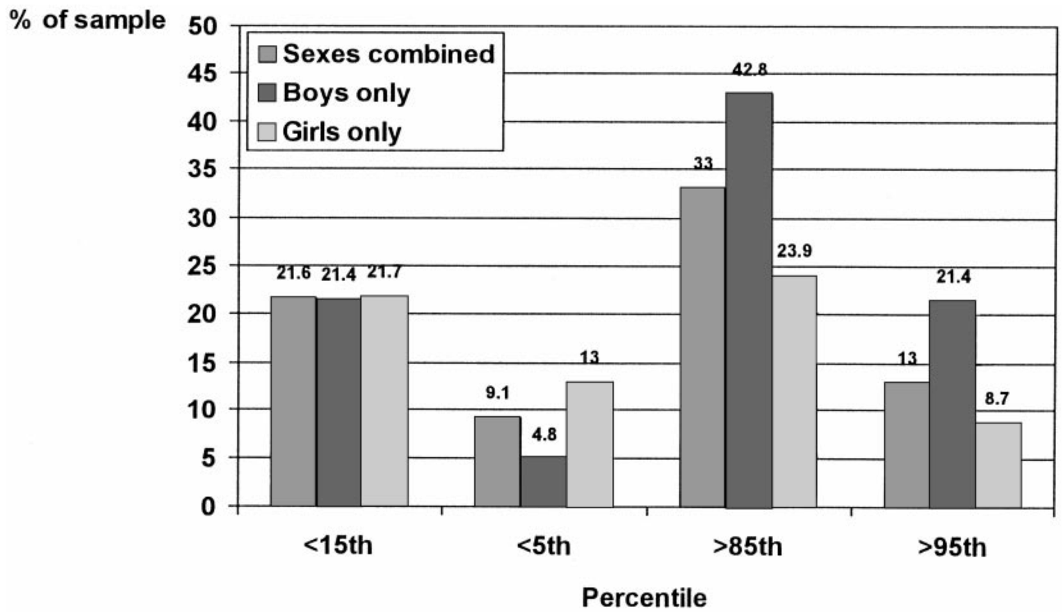

Fig. 3. Percentage of children exhibiting low stature (<15th percentile of NCHS reference data) and stunting (<5th percentile of NCHS reference data), and overweight (BMI >85th percentile of NHANES reference data) and obesity (>95th percentile of NHANES reference data).

pared to U.S. references. For clarity of presentation, only height, weight, body mass index, and arm circumference are graphed. While there is much variation among the anthropometric data, two trends are discernible. First, boys are well above the reference means for weight and all measures of body composition, but not height with the exception of the youngest age group. Second, with the exception of 10-year-old girls, girls' height is well below the reference mean, with measures of body composition being close to the reference mean. The 10-year-old girls exhibit the opposite trend, i.e., all anthropometric measures are well above the reference mean. This could be the result of an earlier growth spurt than for the reference girls, but could also be the result of small sample size, although this is the largest N among girls' age groups.

Another way to analyze the growth and nutritional status of the sample is to group children by percentiles. Since this paper is concerned with growth deficits and overweight, only height and body mass index are presented (Fig. 3). The results indicate that 21.6% of the children exhibited low height, with an approximately equal distribution of boys and girls. However, 13% of the girls were stunted (<5th percentile) compared to 4.8% of boys. With respect to body mass index, 33% of all children were above the 85th percentile, with 42.8% of boys compared to 23.9% of girls. Also, 21.4% of boys compared to 8.7% of girls exhibited obesity.

Relationship between socioeconomic measures, growth, and nutritional status

Table 3 indicates that mean HAZ tended to be higher for children with higher socioeconomic measures; these differences reached significance only for father's education (height was significantly greater when fathers had at least a high school education), household employment status (height increased with the number of employed parents), and mother's employment status (height was greatest when the mother was employed). Mean differences in height approached significance for School Lunch Program qualification (i.e., children who qualified for free lunch were shortest and those who paid for their lunch were tallest).

TABLE 3. *Means tests (ANOVA or t-tests) for anthropometric z-scores by socioeconomic measures*[1]

	N	HAZ	WAZ	BMIZ	TRICZ	UACZ	UMAZ	UFAZ
Father's education								
<High school	36	−.457** (0.98)	.138 (1.21)	.417 (1.21)	.479 (1.15)	.562 (1.20)	.416 (1.03)	.540 (1.34)
High school/GED	40	.312** (1.08)	.736 (1.23)	.687 (1.26)	.974 (1.16)	.984 (1.17)	.617 (1.13)	1.028 (1.27)
Postsecondary	12	.282 (1.26)	.470 (1.22)	.406 (0.85)	.558 (0.98)	.763 (1.15)	.708 (1.23)	.640 (1.02)
F		5.448	2.272	0.566	1.955	1.210	0.459	1.470
Significance		.006*	.109	.570	.148	.303	.633	.236
Mother's education								
<High school	26	−.385 (1.01)	.268 (1.18)	.524 (1.16)	.618 (1.21)	.641 (1.20)	.392 (0.99)	.659 (1.35)
High school/GED	45	.118 (1.09)	.583 (1.27)	.642 (1.28)	.870 (1.20)	.960 (1.19)	.684 (1.09)	.958 (1.35)
Postsecondary	17	.242 (1.26)	.404 (1.28)	.284 (1.00)	.452 (0.86)	.523 (1.13)	.421 (1.28)	.469 (0.92)
F		2.249	0.546	0.556	0.953	1.099	0.713	1.057
Significance		.112	.581	.576	.390	.338	.493	.352
Household employment status								
None employed	21	−.503** (0.93)	.328 (1.22)	.695 (1.30)	.768 (1.39)	.738 (1.23)	.388 (0.87)	.820 (1.51)
One employed	37	−.190** (1.13)	.141** (1.13)	.275 (1.02)	.535 (0.92)	.534 (1.01)	.324 (1.03)	.524 (0.98)
Two employed	30	.567** (1.00)	.932** (1.27)	.753 (1.28)	.899 (1.20)	1.117 (1.30)	.933 (1.25)	1.054 (1.40)
F		7.476	3.759	1.597	0.871	2.076	2.958	1.453
Significance		.001*	.027*	.209	.422	.132	.057	.240
Father's employment status								
Not employed	31	−.265 (0.97)	.353 (1.15)	.554 (1.22)	.716 (1.29)	.652 (1.17)	.306 (0.88)	.739 (1.40)
Employed	57	.134 (1.18)	.511 (1.29)	.529 (1.19)	.714 (1.07)	.852 (1.19)	.678 (1.19)	.795 (1.22)
t-test (two-tailed)		−1.611	−0.570	0.094	0.009	−0.755	−1.673	−0.197
Significance		.111	.570	.925	.993	.452	.098	.844
Mother's employment status								
Not employed	48	−.416 (1.07)	.167 (1.18)	.462 (1.17)	.622 (1.12)	.636 (1.10)	.392 (0.98)	.645 (1.21)
Employed	40	.484 (0.98)	.800 (1.23)	.629 (1.22)	.826 (1.17)	.955 (1.27)	.733 (1.22)	.932 (1.35)
t-test (two-tailed)		−4.080	−2.458	−.655	−.835	−1.264	−1.459	−1.052
Significance		.000*	.016*	.514	.406	.210	.148	.296
School Lunch Program qualification								
Free	56	−.201 (0.98)	.361 (1.25)	.558 (1.28)	.743 (1.16)	.765 (1.24)	.493 (1.16)	.798 (1.32)
Reduced	13	.139 (1.10)	.799 (1.15)	.802 (1.15)	.834 (1.54)	1.143 (1.28)	.993 (1.01)	1.014 (1.63)
Not qualified	19	.467 (1.39)	.496 (1.27)	.300 (0.93)	.550 (0.77)	.580 (0.94)	.400 (0.94)	.544 (0.83)
F		2.773	0.670	0.702	0.282	0.884	1.318	0.543
Significance		.068	.514	.499	.755	.417	.273	.583

[1] Standard deviations are in parentheses.
* Indicates significant differences by t-test.
** Indicates significant differences between marked groups only by Bonferroni's post hoc test for ANOVAs.

Mean weights (also Table 3) were significantly higher for households where both parents were employed and for households where mothers were employed. Arm muscle came close to differing significantly when two adults were employed as well. None of the rest of the body composition measures exhibited significant differences among groups of children.

The results of ANOVA via GLM factorial analysis of height and weight by father's and mother's education level and employment status, qualification for the lunch program, and gender are presented in Table 4. Only the main effects and significant (or marginally significant) interactions are presented. In the case of HAZ, mother's employment status is the only significant main effect. The interaction between mother's education and lunch program qualification is significant. In addition, interactions between father's education and father's employment status, and mother's employment status and lunch program qualification, are marginally significant. The ANOVA for WAZ resulted in a nonsignificant model. In addition, although Levene's test was acceptable, it was marginal ($P = 0.063$), indicating that equality of variances might be a problem.

The same tests were run independently for mothers and fathers, i.e., ANOVAs of height and weight on mother's education level and employment status, qualification for free lunch, and gender; the same tests were run for fathers. Both of the tests using the father's variables violated assumptions of equality of variance, and in neither case was the model significant; therefore, the

TABLE 4. Analysis of variance (ANOVA using GLM factorial procedure) for height and weight by father's education level, mother's education level, father's employment status, mother's employment status, qualification for lunch program, and gender[1]

	Sum of squares	df	Mean square	F	Signif-icance
Height (HAZ)					
Model	51.725	31	1.669	1.634	.055
Intercept	1.391	1	1.391	1.363	.248
Father's education	2.480	1	2.480	2.429	.125
Mother's education	2.244	1	2.244	2.198	.144
Father's employment	0.127	1	0.127	0.127	.726
Mother's employment	4.112	1	4.112	4.028	.050
Lunch	0.614	1	0.614	0.602	.441
Gender	0.008	1	0.008	0.008	.929
Father's education * father's employment	3.751	1	3.751	3.674	.060
Mother's education * lunch	4.336	1	4.336	4.247	.044
Mother's employment * lunch	3.336	1	3.336	3.268	.076
Error term	57.173	56	1.021		
Weight (WAZ)					
Model	51.004	31	1.645	1.121	.348
Intercept	0.723	1	0.723	0.492	.486
Father's education	2.724	1	2.724	1.856	.179
Mother's education	4.754	1	4.754	3.239	.077
Father's employment	0.096	1	0.096	0.066	.798
Lunch	2.507	1	2.507	1.708	.197
Gender	0.204	1	0.204	0.139	.711
Error term	82.208	56	1.468		

[1] Main effects and significant interactions are shown.
* By.

TABLE 5. Analysis of variance (ANOVA using GLM factorial procedure) of height and weight on mother's education level and employment status, qualification for lunch program, and gender[1]

	Sum of squares	df	Mean square	F	Signif-icance
Height (HAZ)					
Model	32.187	13	2.476	2.388	.010
Intercept	2.895	1	2.895	2.792	.099
Education	3.517	1	3.517	3.393	.069
Employment	9.119	1	9.119	8.797	.004
Lunch	0.795	1	0.795	0.767	.384
Gender	1.304	1	1.304	1.258	.266
Employment * lunch	4.013	1	4.013	3.871	.053
Employment * gender	3.728	1	3.728	3.597	.062
Lunch * gender	4.436	1	4.436	4.279	.042
Empl * lunch * gender	3.966	1	3.966	3.826	.054
Error term	103.310	74	1.396		
Weight (WAZ)					
Model	29.902	13	2.300	1.648	.091
Intercept	0.013	1	0.013	0.010	.922
Education	3.746	1	3.746	2.683	.106
Employment	5.230	1	5.230	3.746	.057
Lunch	3.289	1	3.289	2.356	.129
Gender	0.009	1	0.009	0.007	.934
Education * employment	4.754	1	4.754	3.405	.069
Employment * gender	5.899	1	5.899	4.226	.043
Lunch * gender	7.165	1	7.165	5.132	.026
Error term	103.310	74	1.396		

[1] Main effects and significant interactions are shown.
* By.

results are not presented. The tests for the mother's variables were significant, although the model for WAZ was marginally so; the results are presented in Table 5. For differences in mean HAZ, there was a significant main effect for employment and a marginally significant effect for education. The significant interactions were employment status by lunch program qualification, lunch program qualification by gender, and employment status by lunch program qualification by gender. In addition, the employment status by gender interaction was marginally significant. In the model for WAZ, there was a significant main effect for employment status, and significant interactions for employment status by gender and lunch program qualification by gender; there was a marginally significant interaction for education by employment status.

DISCUSSION

This paper reports on the growth and nutritional status of a sample of grade-school children in a high-poverty area of eastern Kentucky. It is premised on the idea that poverty environments are risky environments (Huston et al., 1994; Schell, 1986) and present powerful influences on child growth (Johnston, 1995). This paper examines the relationship between specific household circumstances (i.e., socioeconomic factors that tend to occur within poverty environments), child growth, and nutritional status.

Two notes of caution are warranted before discussing these results. The first regards small sample size. Working in small rural communities often limits our ability to show significance in statistical procedures. This does not mean that relationships in the real world do not exist, but that their recognition

statistically may be hampered by small sample size. Nevertheless, research in small communities must be done if we are to understand the lives of people in these communities, recognizing the limits of our data and the procedures used to analyze them. The second caution also concerns limitations of the data, i.e., the inability to quantify complex real-world concepts such as poverty and child growth by reducing them to simple numbers. Johnston and Low (1995) point out that our ability to show any association at all is a testament to the power of the relationship between such highly complex realities as poverty and child growth. With these cautions in mind, I turn to the Discussion.

Analysis of the growth data indicates that poor growth and nutritional status occur among children in this area of high poverty. Compared to the U.S. reference values, low height is seen in over one fifth of the children, with 9.1% exhibiting stunting. This is not an unusual finding for low-income populations, one that is usually interpreted as an accumulation of environmental insults over time. What *is* unusual is that we find this situation not in the developing world, but in the U.S., where social programs are assumed to provide a safety net for poor children against environmental insults resulting from poverty.

The data also indicate that overweight and obesity occur among children at Bridges Elementary School, with one third of the children being overweight, and 13% obese. If, as is argued, childhood behaviors that produce overweight are carried over into adulthood (Bandini and Dietz, 1992; Greenwood et al., 1993; Dietz, 1994; Webber et al., 1995), a large proportion of Bridges children are at risk for overweight- and obesity-related diseases later in life. This is particularly problematic in Kentucky, where the prevalence of overweight and sedentary lifestyle are among the highest in the country and heart disease, cancer, and stroke are the leading causes of death (Kentucky Department for Health Services, Division of Epidemiology, 1994).

Why should these two situations occur, i.e., stunting and obesity, among children at Bridges Elementary School? The analysis reveals significant associations between socioeconomic measures and height and weight, but not body mass index and other body composition variables. This may reflect differences in the nature of the variables. Height and weight are cumulative measures of growth (although weight includes a current component as well), reflecting the sum total of environmental experience over time. While certain circumstances in poverty environments may change from time to time, e.g., employment status, there is some evidence that for most children, poverty is persistent (Miller and Korenman, 1994). Therefore, an association between long-term measures of poor environment and growth should not be surprising, especially if we accept the premise that child growth is a valid marker of the social environment in which it occurs. In the case of Bridges County, deficits in stature may indicate poor biological outcome resulting from a number of factors that occur in poverty environments, e.g., poor housing conditions, dietary quantity and/or quality, access to healthcare, and water quality, all of which are issues for some families in Bridges County.

At the same time, the ANOVAs indicated fewer and less consistent relationships between low socioeconomic measures and weight in this study. Therefore, we may need to look beyond individual and household-level concerns to include community concerns with respect to nutritional status at Bridges Elementary School. For example, overweight and obesity may result from community economics and an infrastructure that provides limited organized and/or safe activity for some children and limited access to high-quality, low-cost food for some families. Reports elsewhere indicate that these structural constraints may contribute to overweight in inner cities (e.g., Curtis and McClellan, 1995; Okamoto et al., 1993; Perez-Escamilla et al., 1997), but rural areas are not immune to these conditions. Access to high-quality, low-cost food can be as problematic for poor people in rural areas as it is for poor people in urban areas (Shotland and Loonin, Public Voice for Food and Health Policy, 1988), contributing to low dietary quality and increasing the risk of overweight. In addition, the risk of overweight

may be exacerbated by lack of activity on the part of children. However, unlike in inner cities, where lack of activity is often attributed to safety concerns, informants in Bridges County tell me that participation in after-school and weekend activities for many children is precluded by lack of transportation into town. Other conversations with local residents suggest that cost, e.g., activity fees and uniforms, may be a factor as well for many families. And, where parents are working, children may not be allowed outside to play after school.

The GLM analysis which attempted to assess the relationships among the socioeconomic measures and child growth was probably hampered by small sample size. Nevertheless, it provided some interesting findings. With respect to stature, it revealed a relationship between father's education and stature that appears to be operating through increased employment for more highly educated fathers. On the other hand, mother's education is less consistent in its significance; mothers' contributions to growth are more likely to come directly from employment interacting with improved poverty status (lunch program qualification). A number of explanations are possible that would require a larger sample size and/or additional data for testing. For example, we might consider the job structure in Bridges County, i.e., is there a gender-stratified job structure that offers differential employment opportunities and/or wages to men and women, irrespective of education level? In addition, family structure may play a mediating role, e.g., in two-parent families, is there a primary and a secondary income, and are they allocated to different things? In a household where two parents are working outside the home, or in a single-parent household where the parent works outside the home, are children less likely to engage in after-school activities due to lack of supervision? And, even though single-parent household status did not correlate with child growth in this sample, would it have done so had the sample size been larger or included more than one male-headed household? An alternative explanation may be that the mother's income is more directly spent on children than is the father's. The literature in developing countries indicates this may be the case; however, the relationship is particularly complex and depends on a number of other factors (Engle, 1989; Islam et al., 1994; Kennedy and Peters, 1992; Tucker, 1989). In a discussion about the contribution made by mothers and fathers to child well-being, a key informant told me, "... to me it seems like the drive is sometimes more in the woman—trying to get the family to do better, to help out." Again, further analysis is precluded by the complexities of the relationship and limited sample size, both of which necessitate additional and, perhaps, different kinds of data. The nature of quantitative data allows for only a minimal understanding of people's lives. Ethnographic data would go much further in helping us sort out these complex situations.

Finally, we must take up the gendered outcome of this research. More girls than boys tended to be stunted, more boys than girls tended to be obese, and a child's gender interacted with the mother's socioeconomic measures in their relationship to height and weight. Why? The increased prevalence of stunting among girls is particularly disturbing, but I have no data by which to assess this outcome. The cross-cultural literature, although not always consistent in its findings, indicates that girls are sometimes differentially treated early in life, the time when the greatest amount of stunting occurs. Cultural assumptions about greater energy requirements for boys may come into play; boys may be more readily taken to the doctor when they are ill, reducing the intensity and/or duration of illness; or boys may be fed higher-quality foods than are girls, all of which can produce differential outcomes in growth. While there is little literature concerning these cultural assumptions in the U.S., there is some evidence that they may hold elsewhere in the developed world, e.g., in England (Charles and Kerr, 1988). The increased prevalence of obesity among boys compared to girls is just as difficult to explain. Again, this may be a function of different patterns of consumption, or it may be related to activity; it may also be the result of different ideas about body image between boys and girls. However, in only a few conversations did children at Bridges

Elementary School express concerns about weight to me, and these were as likely to come from boys as girls.

Finally, the GLM analysis indicates that socioeconomic measures may be operating differentially on boys' and girls' growth. An examination of the ANOVA cells (not presented in this paper) for WAZ indicated that both boys' and girls' weight increased when mothers were employed, but boys' weight increased more than girls'. With respect to gender and lunch program status, as family income increased from 130% (qualification for free lunch) to 185% of the poverty line (qualification for reduced-price lunch), boys' and girls' weights increased similarly. Following that, however, boys' weight dropped dramatically for those children who paid for their lunch, i.e., those above 185% of the poverty line. Girls' weight stayed about the same. Since more boys are obese to begin with, this may indicate that higher income provides some protection against further obesity for boys; it may work through higher-quality diet, or a greater focus on overweight among higher income and better educated parents, or more opportunities for after-school and weekend activities.

With respect to HAZ, when mothers were employed, both boys' and girls' mean height increased, with boys having only a slight edge over girls. As lunch qualification status went from free to reduced-price (130% to 185% of the poverty line), boys' height increased dramatically, but girls' only slightly; from reduced-price lunch status to paid lunch status, girls' height increased more than boys'. This could be interpreted as boys having a faster biological response to environmental improvement, or boys receiving more benefits than girls from an initial improvement in family circumstances. The former may be likely, although the evidence is variable (Stinson, 1985). The latter raises important questions of gender that are often overlooked in research on U.S. children.

In conclusion, this research points to some intriguing findings about poverty environments in the U.S. and the processes leading to outcomes in child growth and nutritional status. In a single community, we find stunting and obesity, and we find that these outcomes differ for boys and girls. We find that stunting can be partially explained by household conditions related to poverty, but that obesity may be more of a community-related phenomenon. We find that employment status, particularly the mother's, is the strongest and most consistent indicator of child growth among those tested. And we find that the relationship between socioeconomic measures and child growth exhibits gender differences. In light of the evidence provided by this research and other research in poor communities in the U.S., e.g., the Turner Nutritional Awareness Project (Johnston and Hallock, 1994), the Ecology of Obesity Project (Gordon-Larsen et al., 1997), and the Hispanic Health Council Growth Study (Perez-Escamilla et al., 1997), I make four recommendations. The first two address biological anthropology research. 1) If we, as anthropologists, are to truly understand the complexities of poverty environments and their effects on child growth and development, we must work with our cultural colleagues; and 2) we must pay more attention to gender in our research than we are wont to do. Grounding our research in ethnography will help us better understand the social and cultural processes through which poverty exerts its influences on child growth and development, something that would have contributed much to this research.

The third and fourth recommendations go to policy. 3) This research indicates that there are negative biological outcomes associated with poverty in the U.S.; our national safety net programs are failing some children. More research which monitors specific child outcomes is necessary if we are to protect children from circumstances like poverty over which they have no control. 4) Finally, the research reported here indicates that child obesity is a problem. These are school-age children who make choices, albeit within limits, in terms of diet and exercise. At school, they choose between two lunch offerings, and within those lunch offerings, they have some choice of what food goes on their plates. They also choose what food actually goes into their mouths. In addition, at school they choose what they will do during recess, e.g., play basketball or sit and talk; after their chores and homework at

home, they choose, within limits, how they will play. Given that as a nation, we are trying to improve public health by promoting more healthful behaviors, this research indicates that nutrition education efforts might benefit from a greater focus on children in addition to the focus on adults. These efforts should also address the particular concerns of families and communities in poverty.

ACKNOWLEDGMENTS

This research would not have been possible without the help of my colleague, the Director of the Family Resource Center at Bridges Elementary School. My thanks go to her, and to the principal, teachers, staff, and parents. Very special thanks go to the children who gave their time, their bodies, their voices, and their opinions to the project. Helpful comments by the editor and two anonymous reviewers on the first draft were much appreciated, as were the comments of Mary Anglin, Sandra Kryst, Nancy Schoenberg, and Ted Steegmann on the revision.

LITERATURE CITED

Bandini LG, Dietz WH. 1992. Myths about childhood obesity. Pediatr Ann 21:647–652.

Bogin B, Sullivan T, Hauspie R, MacVean RB. 1989. Longitudinal growth in height, weight, and bone age of Guatemalan Ladino and Indian schoolchildren. Am J Hum Biol 1:103–113.

Cameron N. 1992. The monitoring of growth and nutritional status in South Africa. Am J Hum Biol. 4:223–234.

Centers for Disease Control. 1990. Anthro software for calculating pediatric anthropometry, version 1.01. Atlanta: Department of Health and Human Services, Public Health Service, Centers for Disease Control, and the Nutrition Unit, World Health Organization, Geneva, Switzerland.

Charles N, Kerr M. 1988. Women, food and families. Manchester, UK: Manchester University Press. 244 p.

Crooks DL. 1994. Relationship between environment and growth for Mopan children in Belize. Am J Hum Biol 6:571–584.

Crooks DL. 1995. American children at risk: poverty and its consequences for children's health, growth, and school achievement. Yrbk Phys Anthropol 38:57–86.

Crooks DL. 1998. Poverty and nutrition in eastern Kentucky: the political-economy of childhood growth. In: Goodman A, Leatherman T, editors. Building a new biocultural synthesis: political-economic perspectives on human biology. Ann Arbor: University of Michigan Press. p 339–355.

Curtis KA, McClellan S. 1995. Falling through the safety net: poverty, food assistance and shopping constraints in an American city. Urban Anthropol 24:93–135.

Dietz WH. 1994. Critical periods in childhood for the development of obesity. Am J Clin Nutr 59:955–959.

Duncan GJ, Brooks-Gunn J, Klebanov PK. 1994. Economic deprivation and early childhood development. Child Dev 65:296–318.

Engle P. 1989. Child care strategies of working and nonworking women in rural and urban Guatemala. In: Leslie J, Paolisso M, editors. Women, work and child welfare in the Third World. Boulder, CO: Westview Press. p 179–200.

Focus. 1995. Measuring poverty: a new approach. Focus 17:(1)2–11.

Focus. 1998. Improving the measurement of American poverty. Focus 19:(1)2–5.

Frisancho AR. 1990. Anthropometric standards for the assessment of growth and nutritional status. Ann Arbor: University of Michigan Press.

Gordon-Larsen P, Zemel BS, Johnston FE. 1997. Secular changes in stature, weight, fatness, overweight, and obesity in urban African American adolescents from the mid-1950s to the mid-1990s. Am J Hum Biol 9:675–688.

Greenwood MRC, Johnson PR, Karp RJ, Wolman PG, Hurley J, Snyder E. 1993. Obesity in disadvantaged children. In: Karp RJ, editor. Malnourished children in the United States: caught in the cycle of poverty. New York: Springer Publishing Company. p 115–129.

Huston AC, McLoyd VC, Coll CG. 1994. Children and poverty: issues in contemporary research. Child Dev 65:275–282.

Islam MA, Rahman MM, Mahalanabis D. 1994. Maternal and socioeconomic factors and the risk of severe malnutrition in a child: a case-control study. Eur J Clin Nutr 48:416–424.

Johnston FE. 1995. Environmental constraints on growth: extent and significance. In: Hauspie R, Lindgren G, Falkner F. editors. Essays on auxology. Welwyn Garden City: Castlemead Publications. p 375–386.

Johnston FE, Hallock RJ. 1994. Physical growth, nutritional status, and dietary intake of African-American middle school students from Philadelphia. Am J Hum Biol 6:741–747.

Johnston FE, Low SM. 1995. Children of the urban poor: the sociocultural environment of growth, development, and malnutrition in Guatemala City. Boulder, CO: Westview Press. 189 p.

Jones DY, Nesheim MC, Habicht J-P. 1985. Influences in child growth associated with poverty in the 1970's: an examination of HANESI and HANESII, cross-sectional US national surveys. Am J Clin Nutr 42:714–724.

Kennedy E, Peters P. 1992. Household food security and child nutrition: the interaction of income and gender of household head. World Dev 29:1077–1085.

Kentucky Cabinet for Economic Development, Division of Research. 1996. Kentucky deskbook of economic statistics. Frankfort, Kentucky: Kentucky Cabinet for Economic Development, Division of Research.

Kentucky Department for Health Services, Division of Epidemiology. 1994. Health behavior trends 1991–1993, Kentucky lifestyles. Frankfort, Kentucky: Kentucky Department for Health Services, Division of Epidemiology. 33 p.

Kuczmarski RJ, Flegal KM, Campbell SM, Johnson CL. 1994. Increasing prevalence of overweight among US adults. JAMA 272:205–211.

Miller JE, Korenman S. 1994. Poverty and children's nutritional status in the United States. Am J Epidemol 140:233–243.

MMWR. 1997. Update: prevalence of overweight among children, adolescents, and adults—United States, 1988–1994. MMWR 46:199–202.

Mueller CW, Parcel TI. 1981. Measures of socioeconomic status: alternatives and recommendations. Child Dev 52:13–30.
Okamoto E, Davidson LL, Conner DR. 1993. High prevalence of overweight in inner-city schoolchildren. Am J Dis Child 147:155–159.
Perez-Escamilla R, Himmelgreen DA, Ferris A. 1997. Community nutritional problems among Latino children in Hartford, CT. Connecticut Family Nutrition Program technical report #1, Storrs and Hartford CT. 52 p.
Popkin BM. 1994. The nutrition transition in low-income countries: an emerging crisis. Nutr Rev 52:285–298.
Popkin BM, Richards MK, Montiero CA. 1996. Stunting is associated with overweight in children of four nations that are undergoing the nutrition transition. J Nutr 126:3009–3016.
Ravallion M. 1996. Issues in measure and modelling poverty. Economic J 106:1328–1343.
Rural Sociological Society Task Force on Persistent Poverty. 1993. Persistent poverty in rural America. Boulder, CO: Westview Press. 379 p.
Schell LM. 1986. Community health assessment through physical anthropology: auxological epidemiology. Hum Org 45:321–327.
Sherry B, Springer DA, Connell FA, Garrett SM. 1992. Short, thin, or obese? Comparing growth indexes of children from high- and low-poverty areas. J Am Diet Assoc 92:1092–1095.
Shotland J, Loonin D. 1988. Patterns of risk: The nutritional status of the rural poor. A report by Public Voice for Food and Health Policy. Washington, DC: Public Voice. 169 p.
Singh LP, Harrison GP. 1997. The impact of caste on the growth of male Sikhs in Punjab, India. Ann Hum Biol 24:131–139.
Stinson S. 1985. Sex differences in environmental sensitivity during growth and development. Yrbk Phys Anthropol 28:123–148.
Trowbridge FL. 1984. Prevalence of growth stunting and obesity: Pediatric Nutritional Surveillance System, 1982. MMWR 32:23–26.
Tucker K. 1989. Maternal employment, differentiation, and child health and nutrition in Panama. In: Leslie J, Paolisso M, editors. Women, work and child welfare in the Third World. Boulder, CO: Westview Press. p 161–178.
Webber LS, Osganian V, Luepker RV, Feldman HA, Stone EJ, Elder JP, Perry CL, Nader PR, Parcel GS, Broyles SL, McKinlay SM. 1995. Cardiovascular risk factors among third grade children in four regions of the United States: the Catch Study. Am J Epidemiol 141:428–439.